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Campus Delivery Cart Design

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***Abstract*—In the field of campus logistics in China, traditional delivery methods mainly rely on manual handling or simple means of transportation. These methods suffer from low efficiency and high costs, which may adversely affect the timeliness and economy of campus logistics. To address this issue, we propose the "Campus Delivery Cart" project. This cart is equipped with an intelligent control system based on the TRAVEO™ T2G CYT4BB7 microcontroller unit and integrates a GPS positioning module, enabling automatic navigation and positioning. The core design of the cart includes intelligent path planning and obstacle avoidance technology, as well as a user interface, allowing the cart to flexibly deliver goods within the campus. This innovative design significantly improves delivery efficiency, enabling faculty and students to receive goods more conveniently and enhancing the overall logistics experience.**

***Keywords* — Campus Logistics; Automation; Intelligent Navigation; Obstacle Avoidance Technology; User Interaction**

I. INTRODUCTION

In the field of campus logistics in China, the increasing demand for convenient services among faculty and students has outpaced the capabilities of traditional manual handling and simple transportation methods, which can no longer meet the demands for efficient and cost-effective logistics. These traditional methods not only consume a significant amount of labor and time but also disrupt the smoothness of campus life. Particularly within the campus environment, frequent goods handling has become a notable pain point, reducing delivery efficiency and diminishing the campus experience for faculty and students[1]. To avoid the time and physical effort associated with frequent handling and to improve the efficiency of logistics and delivery, designing an intelligent delivery cart is particularly necessary.

At present, campus logistics in China mainly rely on a combination of manual labor and tools, which poses several inconveniences in practical operations. For instance, using manual carts or electric vehicles for delivery is only suitable for small-scale or specific area distribution and does not meet the needs of large-scale or multi-area campus environments[2]. Another method is manual handling, which requires personnel to personally pick up and deliver goods. Although this method can adapt to various delivery modes, it requires dedicated individuals for handling, or those in the delivery process to handle the goods, which impacts both the deliverer and receiver in terms of status, physical effort, and time, thereby undermining the efficiency and experience of logistics delivery[3].

Therefore, to avoid the time and physical effort associated with frequent handling and to enhance the efficiency of logistics and delivery, there is an urgent need to design an intelligent delivery cart. By introducing intelligent control technology, it is possible to design an intelligent cart capable of autonomous navigation and delivering goods in various scenarios, thereby providing a more convenient, efficient, and enjoyable logistics experience for campus faculty and students. Such a cart would become an essential piece of equipment in the campus logistics system, significantly improving the efficiency of delivery and the experience of faculty and students, and also promoting the development of intelligent campus logistics in China.

II. SYSTEM SOFTWARE DESIGN APPROACH

The software for this system is designed specifically for the "Campus Delivery Cart" project and is developed on an embedded platform. It integrates path planning, obstacle avoidance logic, and a user interaction interface to meet the specific needs of campus logistics. The system employs the Dijkstra algorithm for path planning, ensuring that the cart takes the shortest and most efficient route from the starting point to the destination while navigating the complex geography and traffic conditions of the campus[4]. The obstacle avoidance system combines ultrasonic and laser sensors to achieve real-time detection of dynamic and static obstacles within the campus, providing comprehensive environmental awareness for safe navigation in complex campus environments.

The user interaction interface utilizes a 1.8-inch TFT screen, offering an intuitive operation menu that allows users to easily input delivery instructions and manage delivery tasks[5]. The interface design takes into account the usage habits of faculty and students, ensuring usability and accessibility. The main control unit of the cart is equipped with a high-performance microprocessor, which has strong data processing capabilities and a wealth of interface resources. It is responsible for processing sensor data, executing path planning algorithms, responding to user commands, and controlling the cart's motors and servos.

The system employs a PID control algorithm to precisely control the cart's direction and speed. Through real-time feedback and adjustments, it quickly responds to path deviations, ensuring stable operation along the predetermined route. The system forms a closed-loop control circuit, where sensors continuously monitor the cart's status, the controller calculates control signals, and the actuators respond to adjust the cart's movement, ensuring precise control over the delivery path.

The system design also considers future scalability, allowing for the addition of new functional modules or upgrades to existing algorithms to enhance system performance. This includes the introduction of more advanced path planning algorithms and improved obstacle avoidance technologies to adapt to the ever-changing campus environment and demands. Through this design, the campus delivery cart system software can achieve intelligent logistics delivery, improve campus logistics efficiency, reduce labor costs, and provide convenient delivery services for faculty and students. The design and implementation of the system closely align with the project

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implementation plan, ensuring technical feasibility, economic rationality, and market adaptability, thus bringing significant benefits and improvements to campus logistics management.

III. SYSTEM HARDWARE DESIGN

The system utilizes a DRV8701 motor driver to control a DC motor, with the TRAVEO™ T2G CYT4BB7 serving as the main control unit. The system collects GPS data via a serial interface. Operating at a voltage of 12V, the system employs a step-down converter to achieve the appropriate working voltage for both the motor and the microcontroller.

A. Circuit Diagram

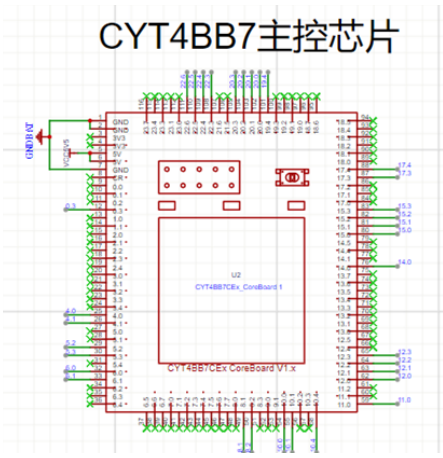

Figure 1: CYT4BB7 Chip Pinout Diagram

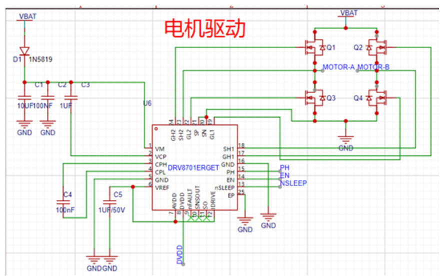

Figure 2: DRV8701 Driver Schematic Diagram

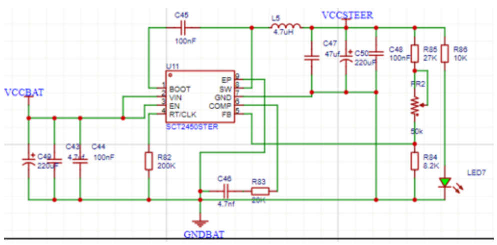

Figure 3: Servo Power Schematic Diagram

B. Control Chip

The TRAVEO™ T2G CYT4BB7 chip is a high-performance 32-bit microcontroller based on the Arm® Cortex®-M7 core, with a maximum operating frequency of 250MHz, providing powerful computing capabilities. This chip integrates up to 4160KB of flash memory and 768KB of SRAM[6], offering ample storage space for complex control algorithms and data processing. Additionally, the TRAVEO™ T2G CYT4BB7 features a rich set of communication interfaces, including CAN FD, LIN, and Ethernet, to meet the communication needs of the campus delivery cart in various environments. It also includes a high-precision ADC and multiple timers/counters to provide precise timing control for sensor data acquisition and motor control. Choosing this chip as the control unit for the campus delivery cart not only meets the demands of complex algorithms and data processing but also allows for easy integration of various sensors and external devices, enhancing the system's scalability. Furthermore, its low-power design helps extend the cart's operating time and reduce energy consumption.

C. GPS Module

The GPS module used in this project is the Zhufei Dual-Frequency GPS, which, due to its high precision and sensitivity, serves as the core component of the intelligent navigation and positioning system for the campus delivery cart. This module is compatible with major global satellite navigation systems, including the American GPS, Russian GLONASS, Chinese BeiDou, and European GALILEO, ensuring stable and reliable positioning services even in changing environments. The module design supports the reception of GPS signals in the L1 and L5 frequency bands, as well as the BDS B1I and B2A bands, GLONASS L1OF band, and GALILEO E1 and E5A bands, enhancing its signal reception capability. In dual-frequency mode, its positioning accuracy can reach within 1 meter (with algorithm design, the range can be reduced to 0.5 meters), making it highly suitable for applications with stringent accuracy requirements. The data update rate is adjustable, with a maximum of 10Hz and a default setting of 1Hz, meeting the real-time positioning demands in dynamic environments. Additionally, the module can operate stably within a temperature range of -40°C to +85°C, adapting to various climatic conditions.

IV. CONCLUSION AND OUTLOOK

The "Campus Delivery Cart" project addresses the issues of low efficiency and high costs associated with traditional delivery methods in the domestic campus logistics sector by proposing an intelligent control system based on the TRAVEO™ T2G CYT4BB7 microcontroller unit and GPS positioning module. This system achieves automatic delivery of goods within the campus through intelligent path planning and obstacle avoidance technology, combined with a user interaction interface, significantly improving delivery efficiency and enabling faculty and students to receive goods more conveniently, thereby enhancing the overall logistics experience.

Debugging results indicate that our system has achieved significant improvements in the efficiency and quality of campus logistics delivery, reducing labor costs while greatly enriching the logistics experience for faculty and students. The system ensures that goods can reach their destinations safely and quickly through real-time path planning and obstacle avoidance technology, providing an innovative intelligent solution for campus logistics.

Looking to the future, we plan to continue improving and upgrading the system. We will optimize the path planning algorithm to adapt to the ever-changing traffic and environmental conditions on campus, ensuring that the cart can efficiently complete tasks in various situations. We are also

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committed to enhancing the accuracy and response speed of the obstacle avoidance system, ensuring stable operation even in complex environments. The addition of an automatic charging feature will extend the cart's operating time, reduce manual intervention, and improve the system's independence and reliability. Furthermore, we will develop a mobile app or remote control platform, allowing campus administrators and students to monitor the cart's operational status and delivery progress in real-time, facilitating more convenient remote management and feedback.

Through these improvements, we believe the campus delivery cart system will better meet the actual needs of users, providing more comprehensive and convenient services for faculty and students while promoting the advancement of intelligent campus logistics to a higher level.

REFERENCES

[1] Huang Lili. Application and Prospect of Takeout Self-Pickup Lockers in Campus Takeout Distribution [J]. Business Exhibition Economy, 2021-06-15.

[2] Lu Miaojia, Yin Qinyi. The Development Status and Application Prospect of "Last Mile" Autonomous Vehicle Delivery [J]. Comprehensive Transportation, 2021, 43(1): 117-121.

[3] CheBai Think Tank. The Current Status, Challenges, and Suggestions for the Commercialization of Autonomous Delivery in China [J]. Intelligent Connected Vehicles, 2020(02): 60-67.

[4] Chen Qingyu, Yuan Wenbo, Du Wenxue, Li Shi, Wang Qinruo. Simulation Application of a Shortest Path Algorithm in Path Planning [J]. Electronic World, 2019(03): 20-23.

[5] Luo Shijian, Gong Hebo, Lin Wei. Current Status and Progress of Research on Interactive Design of Intelligent Products [J]. Journal of Mechanical Engineering, 2023-03-22.

[6] Zhang Yijiang, Wang Shaojun, Fu Ning. An Overview of Microcontrollers [J]. Principles and Interface Technologies of Microcontrollers, 2016(07): 3-13.

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